TECHNICAL ASSESSMENT DOCUMENT:

FURTHER STUDY MEASURE 8
BLOWDOWN SYSTEMS

December 2002

DRAFT Revision 2
DO NOT CITE OR QUOTE

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Reviewed by:
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Engineering Manager

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I. EXECUTIVE SUMMARY

As part of the San Francisco Bay Area 2001 Ozone Attainment Plan for the 1-Hour National Ozone Standard, the Bay Area Air Quality Management District (BAAQMD or District) committed to study several activities to determine if additional emission reductions could be achieved and whether implementation of control measures is feasible. The District has the lead for Further Study Measure FS-8 for Pressure Relief Devices (PRDs), Blowdown Systems, and Flares. This technical assessment document (TAD) presents the findings for blowdown systems. Separate TADs are being prepared for the other portions of this study. Participation in this study included the California Air Resources Board (ARB), the Environmental Protection Agency (EPA), affected industry, and the public.

A. Scope of Technical Assessment

All process units in refineries are subject to operational upsets that must be controlled in a safe and effective manner. These upsets result from instrument failures, loss of cooling water, loss of steam, loss of power and a number of other atypical operating conditions. In order to protect process vessels from overpressure and rupture, control valves and PRDs are used to relieve excess pressures directly to the atmosphere, to an uncontrolled blowdown system, or to a blowdown system controlled by a flare. This technical assessment document deals only with uncontrolled blowdown systems.

Four uncontrolled blowdown systems were identified. All four systems are at the Tesoro Refinery located at Avon. Blowdown systems provide for the safe disposal of hydrocarbons, liquid and gases, that are either automatically vented from the process units through PRDs, or manually drawn from units. These units gather relief flow, separate liquid from vapors, recover any condensable oil and water and discharge the vapors into the atmosphere. They are used during start-up, shutdown and upset or atypical operating conditions.

B. Findings

1. Emission Inventory

The emissions from blowdown systems are episodic in nature. The emissions from these blowdown systems are presently estimated to be 7 tons of VOC per day, annual average. However because of their episodic nature, annual average emissions do not accurately depict air quality impact of these sources.

2. Episodes

VOC emissions were estimated to range between 2 and 225 tons for a specific episode that occurred on May 17, 2001.

3. Potential Control strategies

Two types of potential control strategies to control emissions from uncontrolled blowdown systems have been identified, prevention and control.

4. Monitoring

Emissions from uncontrolled blowdown systems should be continuously monitored. Based on the monitoring results, a review of the existing regulatory requirements should be reviewed and considered.

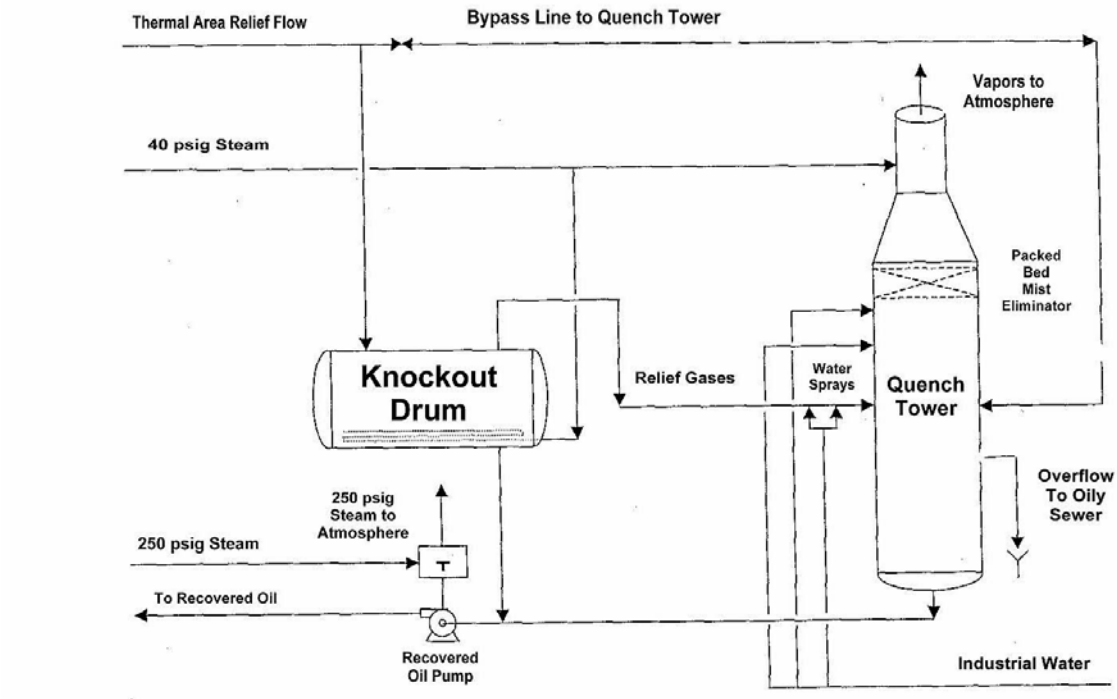
II. Introduction

A. Background

All process units in refineries are subject to operational upsets that must be handled in a safe and effective manner. This includes instrument failures, loss of cooling water, loss of steam, loss of power and a number of atypical operating conditions. In order to protect product vessels from overpressure and rupture, these fluids are typically released, directly to the atmosphere, to an uncontrolled blowdown system, or to a blowdown system controlled by a flare. Blowdown systems provide for the safe disposal of hydrocarbons, liquid and gases, that are either automatically vented from the process units through PRDs or manually drawn from units using control valves or block valves. Blowdown systems collect relief flows, separate liquids from vapors, recover any condensable oil and water and discharge the vapors into the atmosphere. Process units are typically purged to the blowdown system prior to shutdown and startup. Four uncontrolled blowdown systems were identified. All four systems are located at the Tesoro Refinery in Martinez.

Figure 1 is a simplified flow diagram of one of the four uncontrolled blowdown systems. Each of the four-blowdown systems is different. Two blowdown systems do not have packed bed mist eliminators, heat in the stack, or heating coils in the knockout drum.

Figure 1: Uncontrolled Blowdown System



Each uncontrolled blowdown system services a different section of the Tesoro Refinery, Crude Unit 50, (Figure 2), Crude Unit 3 (Figure 3), Fluid Catalytic Cracking Area (Figure 4), and Coker Area (Figure 5). Relief gases are transported from each of the four areas to the top of a knockout drum. Typically, there should be no flow to the drum. Flow should only be present during startup, shutdown, or upset conditions. The purpose of the knockout drum is to separate gases from liquids. Liquids fall to the bottom and are manually pumped to tanks for reprocessing. The operator must anticipate when flow is present and manually activate the pump. There are a number of ways an operator determines that flow is present, including communication with staff, high temperature, high pressure, spray flow alarm, or high level alarm.

Figure 2: Crude Unit 50 Blowdown System

Figure 3: Crude Unit 3 Blowdown System

Figure 4: FCCU Blowdown System

Figure 5: Coker Blowdown System

Knockout drums on two of the blowdown systems have a steam coil. The steam coil keeps heavy hydrocarbons fluid and "weathers off light hydrocarbons". Vapors and mist exit the top of the drum and proceed to the side of the quench tower. Wastewater sprays are used to remove condensable hydrocarbons, which fall to the bottom of the quench tower. The liquid hydrocarbons overflow to the oily sewer. The remaining vapors exit through the top of the tower. Steam flows into the stack to prevent air from entering and creating an explosive mixture. Table 1 shows the different features of the four uncontrolled blowdown systems.

Table 1: Uncontrolled Blowdown System Features

	Heating Coils	**Packed Bed Mist Eliminator**
Crude Unit 50		
Crude Unit 3	X	X
Cat. Cracker		
Coker	X	

B. Existing Regulations

No local air district in California has a regulation that specifically limits emissions from blowdown systems. Regulation 8, Rule 2, Miscellaneous Operations is intended to control precursor organic compound emissions from miscellaneous operations to a level below 15 pounds per day and 300 ppm. A miscellaneous operation is defined as any operation other than those subject to the other Rules in Regulation 8 and the Rules in Regulation 10. Regulation 10 referneces the federal New Source Performance Standards in 40 CFR Part 60, Subpart J.

III. SUPPORTING DATA AND DISCUSSION

A. Inventory

EPA's latest emission factors for these types of systems were reviewed. Using the U.S. EPA's AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Chapter 5.1. Emissions are estimated to be 7 tons of VOC per day for the four systems.

In addition, emissions were estimated assuming flows to uncontrolled blowdown systems are no different than other controlled blowdown systems. Emissions estimates ranged between 25 to 130 tons of VOC per day (See Page 12 of the Appendix).

B. Testing

Two of the four uncontrolled blowdown systems were tested. The Crude Unit 50 blowdown system was tested after the system was cleaned and gas freed. The Crude Unit 3 blowdown system was tested when there was no flow to the system. The source test result summaries are contained in the appendix.

The results indicate that VOC emissions were vented to atmosphere during startup of Crude Unit 50. The emissions were estimated at 220 lbs/day of VOC.

Testing of Crude Unit 3 blowdown system showed 0.07 pounds per day of VOC emissions. There was no quenching during the test. This is a clear indication that no venting occurred during the test. The system's frequency of operation has yet to be determined by the District. Plant personnel report that the system is rarely used.

C. Investigation of Episodes

Since no significant emission data exists, a single event that occurred on May 17, 2001 was analyzed. This event caused the ambient H_2S standard to be exceeded as detected by a ground-level monitor. The facility did not provide any data on the cause of the release or the emissions. The event had duration of about 15 minutes and caused a peak concentration of 167 ppb H_2S. An assumed H_2S concentration for the vent gas stream and a simple dispersion model was used to estimate the amount of VOC emissions from this event. The estimate of VOC emissions ranged between 2 and 225 tons. See appendix for calculations.

A number of additional episodes are currently being investigated and will be included in this document when they are completed. These episodes occurred on September 12, 2002, October 19, 2002 and December 10, 2002.

IV. IMPACTS

A. Emissions and Emission Reductions

There are no direct measurement devices on the uncontrolled blowdown systems. VOC testing and flow monitoring are underway. The emissions and any potential reductions will be determined after completing the analysis of the data.

B. Economic Impacts

The cost to control these systems has not been determined. Possible controls would include source reduction and venting these sources to a fuel gas recovery and flare system.

V. APPENDIX

- **Source Test Results**
- **Estimate of Emission Range for NOV A10150 (Episode Modeling)**
- **Calculation of Emissions**

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 02193
Test Date: 06/16 - 21/02

Test Times:
Run A: SEE BELOW
Run B:
Run C:

Source Information

Firm Name and Address:
Tesoro
Avon Refinery
Martinez, CA 94553

Firm Representative and Title:
Pat Covert
Environmental Services Manager
Phone No. (925) 228 - 1220

Source(s): # 50 Crude Blowdown Unit Exhaust; (S-834)

Plant No. B2758 Permit Con.
Operates: 24 Hrs Per Day 365 Days/Yr

Permit Conditions:

BAAQMD Representatives

Source Test Team:
B. Bartley
G. Bradbury

Permit Services / Enforcement:

Test Requested by:
T. Carter

Operating Parameters: All testing was done during a start up of # 50 Crude Unit.

Applicable Regulations: Developmental Data — VN Recommended: NO

Source Test Results and Comments:

METHOD	PARAMETER	RESULTS					
	Dates :	6/16/02	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02
	Times :	1400 - 2400	0000 - 2400	0000 - 2400	0000 - 2400	0000 - 2400	0000 - 1000
	Volumetric Flowrate; SDCFM *	30	2,140	1,120	70	1,340	2,700
ST-14	Oxygen, %	19.6	20.0	20.6	20.6	20.7	20.7
ST-5	Carbon Dioxide, %	0.12	0.08	0.03	0.02	0.02	0.02
ST - 19	Sulfur Dioxide; ppm	<10	<10	<10	<10	<10	<10
	Sulfur Dioxide; Estimated Lbs / Day	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
ST-7	Methane, ppm	20	30	10	100	190	60
	NMOC, ppm	25,100	5,770	80	740	1,090	640
	NMOC, Estimated Lbs / Day	11	220	6	5	53	115

* Estimated flowrate based on average pressure transducer readings and ambient conditions.

Note: Approximately 56 % of the hydrocarbon emission occurred during three nitrogen purges of the # 50 Crude Unit into the blowdown vessel. All estimated daily hydrocarbon emissions are to be considered **worst case** because all of the pressure transducer readings for calculating flowrates were at baseline levels.

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer — Date	Supervising Air Quality Engineer — Date	Approved by Air Quality Engineering Manager — Date
Bob Bartley 9-4-02 B. Bartley	G. Fend 9/9/2	K. Kunanlec 9/9/02 K. Kunanlec

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COMPLIANCE AND ENFORCEMENT DIVISION

OFFICE MEMORANDUM

11/20/02

TO: AIR QUALITY ENGINEERING MANAGER

FROM: PRINCIPAL AIR QUALITY ENGINEER

SUBJECT: ESTIMATE OF EMISSION RANGE FOR NOV A10150

My memo of 11/8/02 estimated the emissions that resulted from Tesoro (then know as Ultramar) venting their No 1 Feed Prep Unit's surge drum to the atmospheric blowdown system on 5/17/01. They were issued NOV A10150 since the Chenery GLM exceeded the H_2S limits of 9-2-301. The potential emissions were estimated as 25 tons of organics.

The emission estimate has been redone as a range to show the effect of the various assumptions made. As reported earlier, Tesoro did not provide an estimate of the emissions due to the NOV and also did not provide any operating conditions for the No 1 Feed Prep Unit as had been requested.

The attached MathCad and ALOHA printouts show the calculations done. The three major assumptions are:

1. Time of the event: 9 minutes if based on peak area from GLM chart or 15 minutes if based on total time of event as per the GLM chart.
2. Amount of hydrocarbon and H_2S in the stream being vented: 5% H_2S and 95% hydrocarbons or 1% H_2S and 99% hydrocarbons.
3. Estimation of H_2S emitted as calculated by the ALOHA dispersion model. ALOHA gives a footprint of the geographical area of where the concentration is above the level of concern set by the user, which is 80 ppb H_2S in this case. This footprint is for zero variation in wind conditions. ALOHA also draws a 95% confidence band outside this footprint to account for variations in wind conditions. If the GLM is located just within the 95% confidence line, the emissions of H_2S are 25 pounds/minute. If the GLM is located between the 95% confidence band and the footprint, the emission rate is 300 pounds H_2S per minute.

The emission estimates are

Case	Time (min)	% H_2S	H_2S Emission Rate (lbs/min)	Organics Emitted (tons)
Minimum	9	5	25	2
Midrange	9	5	300	25
Maximum	15	1	300	225

Attachments:

Following is a printout from MatCAD

Estimation of Blowdown Emissions at Tesoro

For NOV 10150 that occurred on 5/17/01
Estimation of range of organic emissions
11/8/02 memo estimated 25 tons of organics emitted

Data and Assumption Ranges

SO2 Measurements at Chenery GLM on 5/17/01

09:30 76 ppb SO2 ave, 91 ppb peak
09:39 112 ppb SO2 ave, 167 ppb peak

Time of Event

Time based on peak area - 9 minutes
Time based on length of event - 15 minutes

From ALOHA Dispersion modeling

Level of concern used for footprint - 80 ppb H2S
(Footprint is geographical area which sees at least a H2S concentration of 80 ppb)
(Outside the footprint, ALOHA draws a 95% confidence band to account for wind variations)

Source strength for which the GLM is located on the edge of the 95% confidence line drawn by ALOHA to account for wind variation - 25 pounds/min H2S

Source strength for which the GLM falls between the 95% confidence line and the footprint - 300 pounds/min H2S

Organic Concentration in Stream Emitted

Case 1: 5% H2S and 95% organic
Case 2: 1% H2S and 99% organic

Calculation of Amount Organic Emitted

$$\text{OrganicsEmitted}(\text{Time}, \text{SourceStrength}, \text{H2S\_level}) := \left(\frac{\text{SourceStrength}}{\text{H2S\_level}}\right)\cdot(1 - \text{H2S\_level})\cdot\text{Time}$$

Minimum Estimate:

$$\text{OrganicsEmitted}\left(9\cdot\text{min}, 25\cdot\frac{\text{lb}}{\text{min}}, 5\cdot\%\right) = 2\,\text{ton}$$

Midrange Estimate:

$$\text{OrganicsEmitted}\left(9\cdot\text{min}, 300\cdot\frac{\text{lb}}{\text{min}}, 5\cdot\%\right) = 26\,\text{ton}$$

Maximum Estimate

$$\text{OrganicsEmitted}\left(15\cdot\text{min}, 300\cdot\frac{\text{lb}}{\text{min}}, 1\cdot\%\right) = 223\,\text{ton}$$

Following are ALOHA printouts

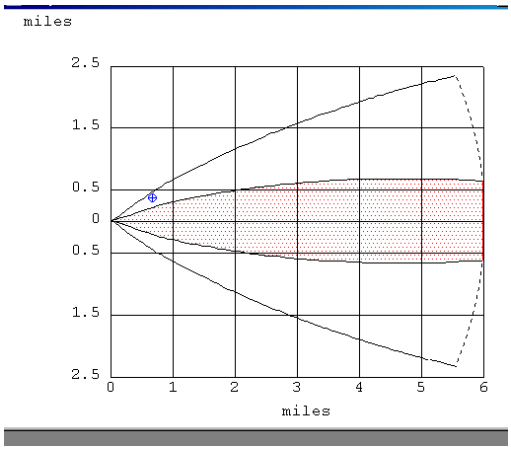
SITE DATA INFORMATION:
Location: MARTINEZ, CALIFORNIA
Building Air Exchanges Per Hour: 0.49 (sheltered single storied)
Time: May 17, 2001 0935 hours PDT (user specified)

CHEMICAL INFORMATION:
Chemical Name: HYDROGEN SULFIDE
Molecular Weight: 34.08 kg/kmol
TLV-TWA: 5 ppm IDLH: 100 ppm
Footprint Level of Concern: 0.08 ppm
Boiling Point: -76.63° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)
Wind: 7 mph from 294° true at 3 meters
No Inversion Height
Stability Class: C Air Temperature: 68° F
Relative Humidity: 50% Ground Roughness: open country
Cloud Cover: 5 tenths

SOURCE STRENGTH INFORMATION:
Direct Source: 300 pounds/min
Source Height: 50 feet
Release Duration: 9 minutes
Release Rate: 300 pounds/min
Total Amount Released: 2,700 pounds
Note: This chemical may flash boil and/or result in two phase flow.

FOOTPRINT INFORMATION: (GAUSS SELECTED)
Dispersion Module: Gaussian
User-specified LOC: 0.08 ppm



Following is a printout from ALOHA (minimum value)

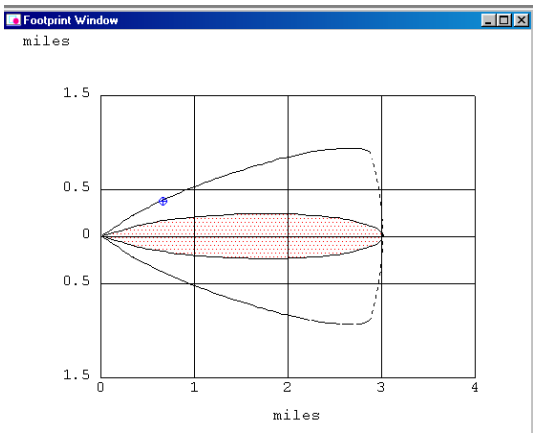
SITE DATA INFORMATION:
Location: MARTINEZ, CALIFORNIA
Building Air Exchanges Per Hour: 0.49 (sheltered single storied)
Time: May 17, 2001 0935 hours PDT (user specified)

CHEMICAL INFORMATION:
Chemical Name: HYDROGEN SULFIDE
Molecular Weight: 34.08 kg/kmol
TLV-TWA: 5 ppm IDLH: 100 ppm
Footprint Level of Concern: 0.08 ppm
Boiling Point: -76.63° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)
Wind: 7 mph from 294° true at 3 meters
No Inversion Height
Stability Class: C Air Temperature: 68° F
Relative Humidity: 50% Ground Roughness: open country
Cloud Cover: 5 tenths

SOURCE STRENGTH INFORMATION:
Direct Source: 25 pounds/min
Source Height: 50 feet
Release Duration: 9 minutes
Release Rate: 25 pounds/min
Total Amount Released: 225 pounds
Note: This chemical may flash boil and/or result in two phase flow.

FOOTPRINT INFORMATION: (GAUSS SELECTED)
Dispersion Module: Gaussian
User-specified LOC: 0.08 ppm



Calculation of Emissions

AP-42

Basis: Emission Factor = 580 lb of hydrocarbon/1000 bbl of refinery feed
Refinery feed = 160,000 barrels of crude per day
Portion of refinery feed going to uncontrolled blowdown system is estimated at 15% (24,000 barrels).

AP-42 estimate: 7 tons of hydrocarbon emissions per day

Typical Flows to Flare System Blowdown Systems

Basis: Typical daily flows to flare system blowdown systems range between 1 and 5 million SCF.
Mole Volume = 379 SCF/mole
Molecular weight = 44 lb/mole
% stream contains hydrocarbons = 50%
Control efficiency = 10%

Daily Flow, SCF	Hydrocarbon Emissions, lb/day	Hydrocarbon Emissions, ton/day
1.0 MM SCF	52,000	25
5.0 MM SCF	260,000	130